

AN OUTBREAK OF MYCOBACTERIAL FURUNCULOSIS ASSOCIATED WITH FOOTBATHS AT A NAIL SALON

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ABSTRACT

Background In September 2000, a physician in northern California described four patients with persistent, culture-negative boils on the lower extremities. The patients had received pedicures at the same nail salon. We identified and investigated an outbreak of *Mycobacterium fortuitum* furunculosis among customers of this nail salon.

Methods Patients were defined as salon customers with persistent skin infections below the knee. A case-control study was conducted that included the first 48 patients identified, and 56 unaffected friends and family members who had had a pedicure at the same salon served as controls. Selected *M. fortuitum* isolates, cultured from patients and the salon environment, were compared by pulsed-field gel electrophoresis.

Results We identified 110 customers of the nail salon who had furunculosis. Cultures from 34 were positive for rapidly growing mycobacteria (32 *M. fortuitum* and 2 unidentified). Most of the affected patients had more than 1 boil (median, 2; range, 1 to 37). All patients and controls had had whirlpool footbaths. Shaving the legs with a razor before pedicure was a risk factor for infection (70 percent of patients vs. 31 percent of controls; adjusted odds ratio, 4.8; 95 percent confidence interval, 2.1 to 11.1). Cultures from all 10 footbaths at the salon yielded *M. fortuitum*. The *M. fortuitum* isolates from three footbaths and 14 patients were indistinguishable by electrophoresis.

Conclusions We identified a large outbreak of rapidly growing mycobacterial infections among persons who had had footbaths and pedicures at one nail salon. Physicians should suspect this cause in patients with persistent furunculosis after exposure to whirlpool footbaths. (N Engl J Med 2002;346:1366-71.)

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RAPIDLY growing mycobacteria are distributed ubiquitously in soil and water, including chlorinated municipal water systems.¹⁻⁵ They are known to cause localized cutaneous infections, such as cellulitis and soft-tissue abscesses, as well as rare extracutaneous or disseminated disease.⁶ Since the first description of *Mycobacterium fortuitum* infection, from an abscess resulting from vitamin injection in 1936,⁷ nosocomial outbreaks of infection with rapidly growing mycobacteria have been documented. These outbreaks are typically associated

with surgical or clinical devices contaminated with water from a hospital or municipal water system.⁸ In the community setting, only sporadic infections have been reported, usually resulting from the contamination of a traumatic wound with soil or water.^{6,9}

On September 26, 2000, a physician in northern California reported to her local health department a cluster of four female patients in whom lower-extremity furunculosis of unknown cause had developed in the previous six months. The patients presented with small erythematous papules that, after several weeks or months, became large, tender, fluctuant, violaceous boils (Fig. 1A). Some progressed to frank ulceration, and some resolved spontaneously with substantial scarring (Fig. 1B). In all four patients, empirical trials of antibiotic therapy had failed, and wound swabs failed to yield bacterial growth on routine culture. The physician noted that all boils occurred below the knee and that all four patients had received pedicures at the same nail salon.

At the salon, we observed that patrons began with a 10-to-15-minute soaking of the lower extremities in a whirlpool footbath. The water levels were always below the knee but often reached to the mid-calf. After the bath, and before working on nails and calluses, the nail technician massaged the leg below the knee with oil or lotion.

We suspected that rapidly growing mycobacteria might be responsible for the disease in these four patients. We undertook an investigation to search for similar cases in the community.

METHODS

Patient Identification

To define the extent of the outbreak, we notified all local primary care and dermatology clinicians of a potential outbreak of mycobacterial disease among customers of the salon, and we asked them to report to the local health department all patients with lower-extremity skin infections in the previous six months who had received a pedicure from the salon. These persons were contacted by local or state health-department staff, and a brief, standardized

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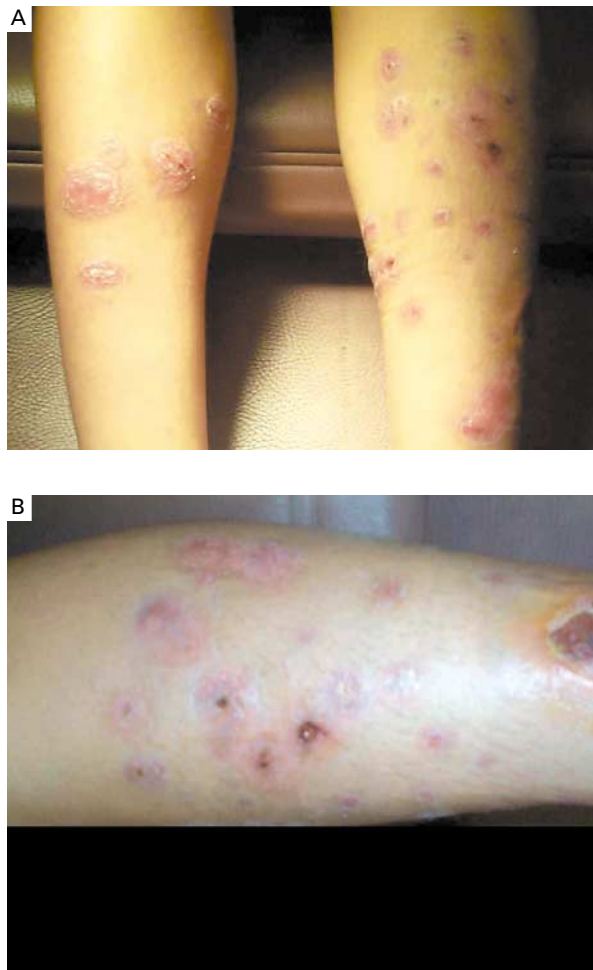


Figure 1. Lesions of Furunculosis. Panel A shows the legs of a 14-year-old girl with typical disease presentation. Panel B shows lesion ulceration and scarring.

questionnaire was administered. Data collected included age, sex, clinical information, and pertinent details of the pedicure procedure.

We defined a patient as any person who had had a pedicure at the salon between April and October 2000 and who had a skin infection below the knee lasting at least two weeks with at least one of the following features: a negative routine bacterial culture, a failure to respond to routine antibiotic therapy, and a treating physician's clinical suspicion of mycobacterial furunculosis.

Case-Control Study

We enrolled the first 48 patients in a case-control study to identify potential risk factors for infection. Because no salon records or sales receipts were available for identifying possible control subjects, we asked the patients to refer unaffected acquaintances, friends, or family members who had had pedicures at the salon in the previous six months to serve as controls. All identified control subjects were included. We used a detailed questionnaire to interview patients and controls. Information collected included sex, age, date of last pedicure, and details of the last pedicure procedure

(e.g., leg shaving before pedicure and the use of lotion or oil during leg massage).

For statistical analysis, patients and controls underwent unmatched and matched comparisons. Because these analyses produced similar results, only the unmatched results are presented here. Mantel-Haenszel odds ratios, 95 percent confidence intervals, and Fisher's exact P values (with the use of two-sided tests) were calculated with Epi Info 2000 software (version 1.0.4).

Environmental Investigation

We obtained multiple environmental samples from the salon for mycobacterial culture, including any substance that came in contact with the patrons' lower legs, specifically massage oils, lotions, bubble soap for the whirlpool bath, tub cleaner, cuticle oil, and exfoliating scrub. Using cotton-tipped swabs, we cultured behind the inlet suction screen of each of the 10 whirlpool-footbath basins in the salon. We obtained tap-water specimens from the salon's sink four and eight weeks after the salon was closed on October 6, 2000.

Laboratory Methods

Physicians were encouraged to obtain punch-biopsy specimens from suspect lesions for routine bacterial and mycobacterial cultures. We requested that all positive mycobacterial cultures be sent to the California Microbial Diseases Laboratory for identification and confirmation of species.

Biopsy specimens submitted to local public health laboratories were decontaminated and digested with *N*-acetyl-L-cysteine (NALC) sodium hydroxide. All environmental culturette specimens were processed in similar fashion.¹⁰ These digests were inoculated onto Lowenstein-Jensen slants, Middlebrook 7H10 plates, and MB/BacT process bottle broth medium (Organon Teknika, Durham, N.C.).

Water samples were concentrated and decontaminated with cetylpyridium chloride, as previously described,¹¹ and inoculated onto Lowenstein-Jensen slants. Lotions, oils, and other cosmetic samples were prepared for processing by mixing 10 ml of sample with 10 ml of sterile Tween 80. This mixture was swirled to make a suspension and mixed with 80 ml of trypticase soy broth at 44°C. Ten milliliters of this prepared sample was then decontaminated with NALC sodium hydroxide, concentrated by centrifugation, and inoculated onto Lowenstein-Jensen and Middlebrook 7H10 culture medium. The remaining 90 ml of sample was filtered through a 0.45- μ m membrane filter, and the filter was placed in 50 ml of Middlebrook 7H9 broth (with MB/BacT antibiotic supplement).

All inoculated mediums and broths were incubated at 35°C. Broth cultures with growth were plated on Middlebrook 7H10. Smears were made from colonies appearing on the medium and were stained with Ziehl-Neelsen stain.¹² Acid-fast colonies were subcultured to Lowenstein-Jensen medium and submitted for high-performance liquid chromatography.¹³ These isolates were identified to the species level with the use of high-performance liquid chromatography and biochemical methods.¹⁴

Molecular Comparison

Selected *M. fortuitum* isolates from patients and from the environment were forwarded to the Tuberculosis/Mycobacteriology Branch of the Centers for Disease Control and Prevention for molecular subtyping by pulsed-field gel electrophoresis and multilocus enzyme electrophoresis. Pulsed-field gel electrophoresis of large restriction fragments of genomic DNA was performed with a restriction enzyme (*Xba*I) according to methods described elsewhere.¹⁵ Gels were interpreted with the use of previously described criteria.¹⁶ For analysis by multilocus enzyme electrophoresis, the mobility of 10 enzymes from each isolate was compared on starch gels with the use of previously described methods.¹⁷ Both molecular subtyping techniques used *M. fortuitum* reference strain American Type Culture Collection 23031.

RESULTS

Identification of Patients

We identified 110 patients in whom furunculosis had developed between April and October 2000 (Fig. 2). Thirty-four (31 percent) had cultures positive for rapidly growing mycobacteria, with 32 identified as *M. fortuitum* and 2 not identified. All patients except one were female, with a median age of 36 years (range, 10 to 65). Most patients had more than 1 boil (median, 2; range, 1 to 37). Because most patients had been to the salon more than once before the onset of disease, we calculated the incubation time for the 13 patients who reported only one visit to the salon, 6 of whom had culture-confirmed disease. The median interval from exposure to clinically apparent infection was 23 days (range, 10 to 128) for these 13 patients; the results from the 6 of these 13 patients with culture-confirmed infection were similar (median, 27 days; range, 12 to 69). No patients were hospitalized, and there were no deaths.

Preliminary information on clinical outcome was reported for 60 patients. Forty-eight patients received oral antibiotics for a median of four months (range, one to seven), and all had resolution of boils. No patients underwent surgical excision of the lesions or received intravenous antibiotics. Clinicians prescribed single- or dual-agent therapy guided by susceptibility testing of early isolates that showed susceptibility to ciprofloxacin, clarithromycin, and doxycycline or minocycline. In 11 of the 12 untreated patients, the boils eventually resolved; 1 patient required treatment after a distal-calf boil led to an abscess deep within the proximal thigh, from which a culture confirmed the presence of *M. fortuitum*.

Case-Control Study

Forty-eight patients were enrolled in the case-control study, of whom 14 had culture-confirmed myco-

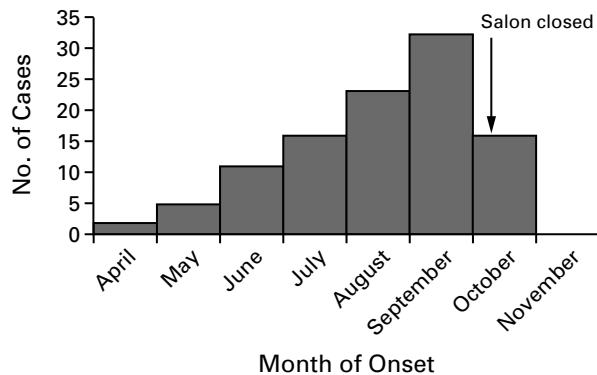


Figure 2. Onset of Infections during the Epidemic.

bacterial infection. Twenty-seven patients identified between 1 and 3 control subjects each, for a total of 56 controls enrolled in the study. Patients and controls did not differ with respect to age (median, 39 years for both) or sex (99 percent of patients and 100 percent of controls were female). No patients or controls reported immunocompromising conditions. More patients than controls had shaved their legs with a razor before the pedicure or had had oil massage during the pedicure (Table 1). All persons who had shaved before the pedicure had done so either the night before or the morning of the pedicure. In a stratified analysis, only leg shaving was significantly associated with infection (adjusted odds ratio, 4.8; 95 percent confidence interval, 2.1 to 11.1).

Environmental Factors

We found large amounts of hair and skin debris behind the inlet suction screen of every whirlpool footbath examined during our initial visit to the salon. The salon owner reported that the areas behind these screens were never cleaned, and cultures from these areas of all 10 footbaths yielded *M. fortuitum*. We found other acid-fast organisms in at least five of the footbaths, including *M. mucogenicum*, *M. smegmatis*, unidentified mycobacteria, and nocardia organisms. All cultures of oils, lotions, whirlpool disinfectant, and whirlpool bubble soap were negative. Salon tap water yielded rapidly growing mycobacteria in the *M. chelonae* (or *M. abscessus*) group.

Molecular Comparison

We compared *M. fortuitum* isolates from six different footbaths and 14 patients using pulsed-field gel electrophoresis. The isolates from all 14 patients and from three footbaths were indistinguishable (represent-

TABLE 1. RISK FACTORS FOR FURUNCULOSIS ASSOCIATED WITH THE NAIL SALON IDENTIFIED AS THE SOURCE OF THE OUTBREAK.

FACTOR	PATIENTS (N=48)	CONTROLS (N=56)	ODDS RATIO (95% CI)*
	no. (%)		
Whirlpool footbath	48 (100)	56 (100)	Undefined
Leg massage	48 (100)	50 (89)	Undefined
Leg shaving†	31 (70)	17 (31)	4.8 (2.1–11.1)
Oil massage‡	35 (78)	31 (56)	2.0 (0.8–4.9)

*Odds ratios were adjusted after stratified analysis. CI denotes confidence interval.

†Percentages are based on 44 patients and 54 controls for whom data were available.

‡Percentages are based on 45 patients and 55 controls for whom data were available.

tative isolates shown in Fig. 3). The three other footbath isolates were distinct from the outbreak strain. Multilocus enzyme electrophoresis was also performed on the six footbath isolates and a subgroup of the isolates from 6 of the 14 patients. These results corroborated our findings: all isolates that matched on pulsed-field gel electrophoresis shared the same electrophoretic type (ET-4).

DISCUSSION

This investigation identified a large community outbreak of *M. fortuitum* furunculosis after the use of contaminated whirlpool footbaths in a northern California nail salon. A single strain of *M. fortuitum* was responsible for the follicular infections, and the same strain was recovered from the footbaths that were used in pedicures. Outbreaks of follicular disease from whirlpools and baths caused by pseudomonas and staphylococcus bacteria have been documented, but only a few sporadic cases of cutaneous infection

with rapidly growing mycobacteria have been reported in this setting.^{18,19} In contrast to the quickly healing and nonscarring lesions of typical folliculitis, this outbreak produced severe, protracted, scarring furunculosis.

Despite the severity of the disease, this large outbreak escaped detection for nearly six months. The patients often delayed seeking medical attention because of the benign nodular appearance and indolent course of early lesions. However, once the lesions worsened and the patients consulted their physicians, the physicians typically cultured and treated for nonmycobacterial skin infection, with no resulting clinical improvement.

Patients who were treated with oral antibiotics with activity against *M. fortuitum* had eventual resolution of boils, and no patient required intravenous therapy or surgical excision of lesions. Although the disease resolved in some untreated patients, one initially untreated patient did have disease dissemination.

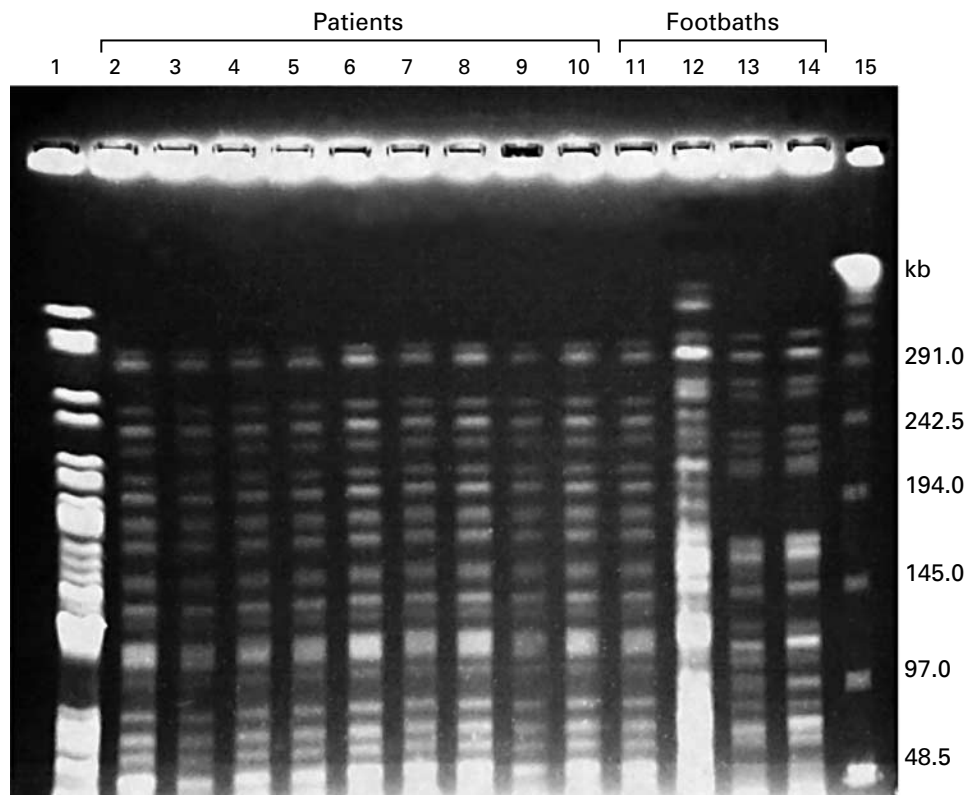


Figure 3. Pulsed-Field Gel Electrophoresis of Representative Isolates from Patients and Whirlpools Obtained with Restriction Enzyme *Xba*I.

Lane 1 shows the reference strain of *Mycobacterium fortuitum* (American Type Culture Collection 23031); lanes 2 through 10 show *M. fortuitum* isolates from nine patients; lanes 11, 12, 13, and 14 show *M. fortuitum* isolates from four whirlpool footbaths; and lane 15 shows a molecular-weight marker (a 48.5-kb lambda ladder).

In this outbreak, it appears that rapidly growing mycobacteria, which commonly inhabit municipal water systems,^{1,3} entered the salon in the tap water, seeded the accumulated organic debris behind the footbath inlet screens, and then multiplied in this warm, nutritive environment. These organisms recirculated within the footbath basin as pedicure customers received footbaths. Because all of the salon's footbaths harbored one or more rapidly growing mycobacterial species, and in some cases even multiple strains of *M. fortuitum*, it is unlikely that the footbaths were contaminated by a patron.

The case-control study identified shaving the legs with a razor as a risk factor for disease in this outbreak. Razor-induced microtrauma of skin epithelium or hair follicles could serve as a portal of infection for these organisms, although one third of the patients did not shave their legs before their pedicure. These were healthy persons with no other identifiable risk factors for disease, and it is unclear why they became infected. One possibility is that the outbreak strain of *M. fortuitum* was highly virulent. Our finding of a single disease-causing strain among several other *M. fortuitum* strains in the salon's footbaths raises this possibility and might explain why outbreaks have not occurred previously in similar settings.

Will similar outbreaks occur in the future? We performed a bacteriologic survey of California nail salons and found rapidly growing mycobacteria to be highly prevalent in whirlpool footbaths. More than one species (*M. fortuitum* and other known pathogens) was found in most machines, even when little debris was present (California Department of Health Services: unpublished data). The nail-care industry is large and growing. In California there are more than 7500 nail salons, and the number of licensed nail technicians has doubled from 40,000 to 80,000 in the past 10 years.²⁰ There may be similar outbreaks in the future. Salon-associated infections may also occur sporadically and not be recognized. After notifying local health departments in California of this outbreak, we were informed of at least six sporadic cases of rapidly growing mycobacterial furunculosis of the lower extremities in pedicure customers at other salons. We helped investigate one such case and documented a molecularly indistinguishable isolate from both the patient and her salon's footbath (unpublished data).

The California Bureau of Barbering and Cosmetology, with our assistance, has developed new state regulations for the nail-care industry. The proposed regulations emphasize frequent cleaning behind the inlet suction screen, but further study is necessary to determine the optimal cleaning and disinfection procedures for these machines. These organisms can be resistant to a variety of disinfectants,^{8,21} and it is unknown whether there is a level of footbath con-

tamination that may be acceptable in terms of infection risk.

The large and unprecedented *M. fortuitum* outbreak we identified affected healthy persons who took whirlpool footbaths as part of pedicures. We believe that these rapidly growing mycobacterial infections associated with nail salons are underrecognized and may increase in prevalence. Clinicians should consider rapidly growing mycobacteria in the differential diagnosis of hard-to-treat furunculosis or other soft-tissue infections of the lower extremity, particularly if the patient has used a footbath at a nail salon.

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